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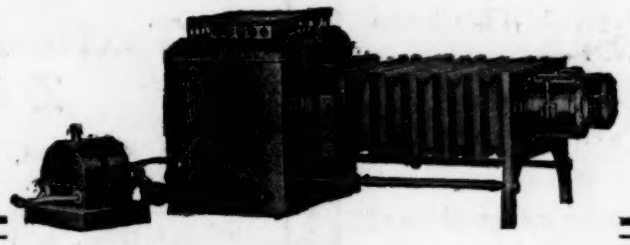

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THE RELATIONS BETWEEN ENGINEERING AND SCIENCE[1]

WE may well approach our subject of the relation between engineering and science by defining these two.

Engineering is the application to man's use of special knowledge of mechanics and of the properties of matter.

Natural science is the correlation of natural phenomena, often combined with their discovery. Emerson says:

> Science is nothing but the finding of analogy, identity in the most remote parts.

This finding of analogy is correlation. But though science has correlation for its essence it also includes discovery. Science thus has two aspects, it correlates the uncorrelated and hence empirically known phenomena, and it discovers new phenomena and correlates them simultaneously. Their correlation is of origin, congenital. Or, if you will not go so far with me, let us agree that engineering is essentially application and science essentially correlation with or without discovery. In this view engineering is not a science but an art with a scientific basis. A man who is an engineer may correlate his own or others' discoveries, as he may walk a mile or pledge a health, but he does it not as an engineer but as simultaneously a natural philosopher.

From this point of view pure science in

[1] Introductory address of the chairman of the Section of Engineering of the American Association for the Advancement of Science given at the meeting held by invitation of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, New York, December 29, 1916.

its relation to engineering seems to-day to be in an intermediate stage of its asymptotic evolution from the state of a follower to that of an absolute dictator. The first reason why this evolution has to follow this general course is that application must needs precede correlation.

Man like the other animals from the very first can survive only as he applies nature's laws to his needs, as he conforms to them, so that he begins applying them inconceivably earlier than he begins to formulate them or even to be capable of formulating them.

The second reason lies in the unfathomable complexity of the laws on which engineering must needs be based.

The engineering of the savage is military. His existence depends on his power to kill his enemies and incidentally his game by means of weapons made from the materials at hand. Of these materials he knows only certain prominent properties irrelated to each other and to the rest of nature. If this knowledge can be said to consist of laws they are only the most minute fragments when compared even with the fragments of laws which we have joined up. They are fragments comminuted to the second degree. The explanation of these fragments the savage has never sought. Yet the laws themselves were as complex when our forefathers were naked as they are to-day. The Bornean or Fiji knows that wood is strong, stone stronger, and iron stronger still, though corruptible by rust. Armed with this and all other knowledge which he has he destroys those who else would destroy him. The survival is not of those who formulate knowledge but of those who best apply it, and so there evolves a race which applies successfully the laws which it may never even think of thinking of.

By and by evolution lifts certain men so far up out of the imperative need of ceaseless viligance lest they be slain by their fellows or by nature as to give them the opportunity to consider their environment, and note the analogies between phenomena which at first seem irrelated. These are the first men of science. Before them the ratio of observed to correlated phenomena was that of a small body to zero, and hence was infinity. With them that ratio fell from infinity to finiteness, but it was still extremely small.

As the accumulation of observed phenomena goes on and with it the organization and elaboration of society, certain men come to excel their fellows sufficiently in their mastery of this knowledge, and in their ingenuity in applying it, to become recognized as a special class, engineers. More slowly the accumulation of observed analogies becomes so great that those who master it become recognized in their turn as a class, the natural philosophers or men of science.

These philosophers address themselves at first to correlating phenomena, which, however familiar, are known as yet only empirically, and thus to explaining that which engineering has long known how to do, has known in part since the days of Assyria, of Homer, and of Kephren. But this is to trail after engineering, to explain its exploits as the minstrel glorifies those of the warrior. By and by science becomes able, through its accumulation of correlations, to point out to the engineer how he may better his service to man. But this is to snatch a share in the leadership, and add it to the continuing labor of correlation.

From this time on science increases continuously the share which it has in the direction of engineering. It is engaged ever more and more in discovering and simultaneously correlating new knowledge, and less and less in the gradually vanishing

work of the correlation of the old empirical knowledge with which alone engineering formerly worked. With the completion of this latter task science might come to be the sole guide of engineering, but for two considerations.

First, as engineering adopts the knowledge which science has correlated it simultaneously unearths new uncorrelated knowledge. Science indeed correlates this in turn, but not instantaneously, so that engineering has always at its hand both that which science has correlated and its own empirical discoveries which science has not yet had time to arrange. As optimists we may well expect that this uncorrelated knowledge will form a gradually decreasing fraction of the whole, but can we expect it ever to vanish completely? Must not science's approach to exclusive leadership be asymptotic?

We begin to get a glimmering of the vastness of the scheme of creation when we remember that every lengthening of man's artificial vision by means of telescope and camera, every new strengthening of telescope, sensitizing of plate, and lengthening of exposure brings a proportional increase in the number of visible suns, telling us that even at that inconceivable distance we have not begun to approach the limit of the discoverable universe. When we turn from telescope to microscope and thence to the inferred constitution of matter, we find with every new refinement of observation and inference a proportional addition of new wonders, a proportional increment in the complexity of natural phenomena. Hence while we may speculate that, as there must be a place where the stars end, so there must be a degree beyond which the subdivision of matter can not go, and a limit to the number of nature's laws, we may well ask whether either that limit or the limit of stellar space will be reached in that little throb in the pulse of the universe which we call the habitable period of this earth. Will man survive long enough to complete the discovery of all laws, so that no uncorrelated phenomena will remain for the engineer to unearth?

The second of the two considerations which tend to postpone the completion of science's leadership is that the beautiful as distinguished from the useful and the good will increase without limit its demands upon the work of the engineer. Though the beautiful itself should in time be capable of complete mathematical analysis, who shall say that that time, now seemingly so inconceivably remote, can arrive during man's earthly stay?

HENRY M. HOWE

OUR PSYCHOLOGICAL ASSOCIATION AND RESEARCH[1]

THE American Psychological Association, like the infants who are among the objects of our study, celebrated its first birthday some months after it was born. We are thus able to hold at the same time our twenty-fifth meeting and mark the completion of nearly twenty-five years of activity. This period covers the working life of most of us and about half the adult life of the science in which we work. Wundt's "Physiologische Psychologie," published in 1874, may be taken to mark the coming of age of the experimental work of Weber, Helmholtz and Fechner. But if psychology as a science was made in Germany, the raw materials were contributed from many nations, many centuries, many sciences; and the leading strings attaching us to Germany were severed at about the time when this association was organized.

[1] Address given on the occasion of the celebration of the twenty-fifth anniversary of the American Psychological Association, New York, December 28, 1916.

Our three great leaders in psychology had made straight the way, James at Harvard, Hall at the Johns Hopkins, Ladd at Yale. The publication of "The Principles of Psychology" in 1890 was a declaration of independence, defining the boundary lines of a new science with unapproachable genius. Simultaneously with the printing of the articles composing James's book, Hall was developing the genetic and educational work in psychology which now occupies such a large place. At that time professorships and laboratories of psychology were established at Clark, Pennsylvania, Harvard, Yale, Wisconsin, Toronto, Cornell, Princeton, Columbia and other universities, and these gave birth to the newer generation now active among us.

Both as significant symbol of the position attained by psychology and as true cause of its further progress, the establishment of the American Psychological Association in 1892 is notable. The American Chemical Society, founded in 1876, was the first of our special scientific societies; it was followed in 1888 by societies of mathematicians and geologists. But our association is among the oldest of the fifty different national organizations now meeting here. The association of those with common interests throughout the nation and the world, so that our neighbors are no longer only or chiefly those living in the same place, is among the most remarkable changes and advances of modern civilization. The social group reacts in much the same way as the local group, there are jealousies, misunderstandings and quarrels, but also respect, friendship and cooperation, and when the group can perform a useful service or is threatened from without it develops a consciousness of kind. Groups of this character, whose individuals are bound together by common interests and objects, may become institutions more dominant over our lives, having greater claims to our loyalty and service, than the conventional family, the helpless church or the blood-stained nation.

Our place of birth was Clark University; the day, July 8, 1892; G. Stanley Hall was our Socrates and mid-wife. The original members numbered twenty-six. It may be worth while to call the roll. Frank Angell, then as now of Stanford University, a lost angel to us, for he is no longer among the fellowship of the saints. J. Mark Baldwin, then of the University of Toronto, whose contributions to psychology have been so notable, also one of the few whose name is absent from our rolls. William Lowe Bryan and Edmund C. Sanford, pioneers in experimental research, now fallen to "that bad eminence," where they bear the load Atlantean of our humbler fates. W. H. Burnham and Bejamin Ives Gilman, the one in a fundamental branch of education, the other in the fine arts, carrying on work somewhat apart from ours, but related to it. William Noyes, recently lost to us, and Edward Cowles, distinguished alienists. Cattell—*adsum*. John Dewey, John the Baptist of democracy, teacher of teachers, modern master of those who know. E. B. Delabarre, then as now at Brown University. W. O. Krohn, then at Clark; Herbert Nichols, then at Harvard; E. W. Scripture, then at Yale, no longer climbing the steep stairs and eating the bitter bread of academic life. James Hyslop, now following the mystic grail. J. G. Hume, of Toronto University, who saved us from a narrow nationalism and with E. H. Griffin, dean and scholar of the Johns Hopkins University, saved us from a narrow empiricism. Joseph Jastrow, our first secretary, who this afternoon is here to tell us of the work in which he himself has been such a great part. George H. Fullerton, my first professional colleague and comrade, acute thinker, one

of our early presidents, now far away. Lightner Witmer, my first student and my successor at Pennsylvania, where he leads in an important field of research. G. T. W. Patrick, of Iowa, and H. K. Wolfe, of Nebraska, influential as teachers and in their work in psychology and philosophy. Last and most honored of the living, G. Stanley Hall and George T. Ladd, our first two presidents, then seeming to be veteran leaders, but now having become my contemporaries, men to whom we owe so much in so many ways, founders not only of our association, but also of psychology.

To the twenty-six original members, five were added by election at the preliminary meeting. Death has taken from us T. Wesley Mills, of McGill, early worker in animal psychology, and H. T. Ormond, of Princeton, distinguished philosopher. Edward Pace seems to be sheltered from us by the wings of the church in the educational work in which he is engaged. Then there were two men elected not only into the association, but selected from the whole world, because they were those whom we wanted and needed, E. B. Titchener and Hugo Münsterberg.

I once wrote: "Harvard with James Münsterberg, Royce . . . surpasses every other university in the world in its opportunity for psychological study and research." Now they all await us "where beyond these voices there is peace"—Hugo Münsterberg, always my friend since our student days in Leipzig, who with the hand of genius threw prodigally broadcast the diverse endowments of his great nation and his great race; William James, "the sweetest, wisest soul of all my days and lands"; there is none like him, none, nor will be; and Josiah Royce, his friend and ours, the well-beloved disciple, who leaves the world darker, now since his light is quenched.

Should the roll be called of the present membership of the association, there would be three hundred and seven to respond, and there are besides ten former members and others who stand among the hundred leading psychologists according to the list which I have compiled by objective methods.[2] The number of those professionally engaged in psychological work has increased nearly tenfold in twenty-five years. The original members represented 14 colleges and universities. There are now 122 institutions in which our members teach. Then the *American Journal of Psychology*, recently established, stood almost alone; now the published directory of American psychological periodicals contains eighteen titles. This is a growth of our work that has scarcely been paralleled in the history of science.

While it is not feasible to name all the individuals now composing the association, it may be well to give some data in regard to their distribution. The numbers in our chief institutions—including my own—are larger than I had supposed before counting them up. They are: Columbia 23,[3] Chicago 11, Cornell and Harvard 10, Clark, Johns Hopkins and Ohio State 8, Illinois and Michigan 7, Iowa, Pennsylvania, Princeton, Wisconsin and Yale 6, Minnesota and Pittsburgh 5, Bryn Mawr, California, New York University, Texas and Western Reserve 4, Brown, Northwestern, Vassar and Wellesley 3. There are 96 institutions with one or two psychologists—32 universities, 42 colleges and 22 normal

[2] They are: Frank Angell, J. Mark Baldwin, J. E. Creighton, Edwin B. Holt, J. H. Hyslop, Herbert Nichols, E. A. Pace, George Santayana, E. W. Scripture and C. A. Strong. Several of them are primarily interested in philosophy; three reside in France. More than 90 per cent. of our psychologists are thus members of the association.

[3] On Christmas day died Naomi Norsworthy, associate professor of educational psychology in the Teachers College, skilled in research, a truly great teacher, a noble woman.

schools in which psychology is being taught by our members.

272 of our 307 members are now or were recently engaged in teaching (including educational administration). This is a larger percentage than in any other science except mathematics. Most of the remaining 35 have also taught. Of these there are eleven who are engaged in work unrelated to psychology, supposing this to be the case for married women, for there are nine women among the eleven. We have one museum curator, two clergymen, and two practising physicians. Then there are sixteen connected with boards of education, hospitals, laboratories of reformatory and charitable institutions and the like. It is not impossible that this group, now so small, may at our fiftieth anniversary surpass in numbers those engaged in teaching.

258, or 84 per cent., of our members are recorded as holding the degree of doctor of philosophy. Psychology is the most academic of all subjects, a larger percentage of psychologists having taken the advanced university degree than is the case in any other science. Thus in a study made several years ago I found that about 60 per cent. of zoologists and of mathematicians, who in this respect come next to psychologists, have taken the degree and the percentage falls to about 10 for anatomists and pathologists. The American universities which have conferred more than two of these degrees are: Columbia 46, Harvard and Chicago 31, Clark 25, Cornell 24, Johns Hopkins and Yale 15, Pennsylvania 11, Iowa 6 and Michigan 4. The foreign universities are: Leipzig 15, Würzburg, Berlin and Freiburg 3. These fourteen institutions have conferred all but 27 of the 258 degrees. But while psychologists have taken their advanced degrees from a small number of institutions their college origin is very wide. They come largely and increasingly from the institutions of the central and western states, but the data at hand do not permit of a numerical statement. In my previous study I found that psychologists were as likely to come from small colleges as from large institutions having strong departments, and that those from the smaller institutions were equally likely to be distinguished.

At our second meeting, held in New York in 1893, Professor Mary W. Calkins and Mrs. C. Ladd Franklin were elected to membership. We were thus tolerably prompt to recognize equality of opportunity for the sexes, and this record we have maintained, for we now have 39 women among our members. Thirteen per cent. of women may be an unlucky number—it does not represent the ratio of the sexes—but it is larger than in any other science. I have recently counted up the number of women in my Biographical Directory, and find that among the 224 psychologists, 9.8 per cent. are women. Zoology stands next with 7.5, and the percentage falls to 2.1 for chemistry and 1.3 for physics and geology. Of our 39 women members 36 have the degree of doctor of philosophy, 11 from Chicago, 5 from Cornell and 3 from Columbia. If we should use the illegitimate method of projecting the curves of attendance in our courses in psychology at Columbia, we could set the date when it will be no longer a coeducational institution.

I think it is safe to state that we are now doing more work in psychology than any other nation. I once counted up the entries in the Index covering the first 25 volumes of the *Zeitschrift für Psychologie*—from 1890 to 1902—containing references to the articles published in the journal or reviewed by it, the more important contributions to psychology from the German point of view. It was disclosed that during this period America led all nations in experi-

mental work, exceeding Great Britain in a ratio of 10 to 1, that in theoretical contributions we were about equal to Great Britain, but were doubled by France and tripled by Germany. In contributions of a physiological and pathological character we fell far below these nations and below Italy, Germany surpassing us in a ratio of nearly 10 to 1. I have found no convenient way of making a similar comparison for the more recent period, and all contemporary international comparisons are now impossible. "Who's Who in Science," published in England in 1913, attributed 84 of the world's leading psychologists to the United States, as compared with 31 to Germany, 27 to England and 13 to France. This is a predominance which according to the book the United States holds in no other science.

We may wonder whether the importance of the work accomplished in this country for psychology has increased in the same ratio as the number of those engaged in it. It would not be fair to expect to see ten Jameses in this room, just as it would be unreasonable to look for five Darwins in England, because its biologists may have increased five-fold in a generation; or twenty Newtons, because the physicists may have increased twenty-fold since his time. But do we have a hundred members doing work as valuable as that of the more productive ten of those whose names I have recalled among our first members? Probably we have; in so far as it may seem otherwise, this may be because there are in the earlier days of a science more opportunities for original departures, but more especially to the fact that the relation of eminence to numbers follows a psychophysic law of its own. The number in a group who become eminent tends to be a constant, dependent on the limitations of the attention and the interest of the members. Thus a savage tribe may have as many distinguished chiefs and warriors as a nation of a hundred million. We may be unable to see the trees for the forest.

It would be impossible in the time allotted to me to give a history of the development of psychology during the past twenty-five years or an account of American contributions. It seems to me that the lines of development, especially in this country, have been in the directions which from the beginning I have followed, though my advocacy and example have doubtless been epiphenomenal. These are to ally psychology and its methods with the natural and exact sciences rather than with philosophy; to replace introspection and verbal descriptions by experiments and measurements; to investigate behavior and conduct rather than mind and consciousness; to study individual and group differences; to make practical applications and develop a profession of applied psychology.

Mr. Dean R. Brimhall has counted up for me—so my own prejudices are eliminated—the papers presented at the twenty-five meetings of the association. The reports have been printed in *The Psychological Review* and *Bulletin*, except those of the first two annual meetings, which were printed in a brochure which was edited by me as secretary. On the chart is shown for five-year periods the percentages of papers in accordance with their character. Applied psychology and individual psychology are cross classes, the same papers being listed for a second time and also largely in both classes. Only a rough subdivision is feasible, but it serves to show the distribution of our interests and the changes that have taken place in the course of twenty-five years.

In order to obtain information concerning present work, I have used the method of the questionnaire—a psychological tool which we owe in large measure to Stanley

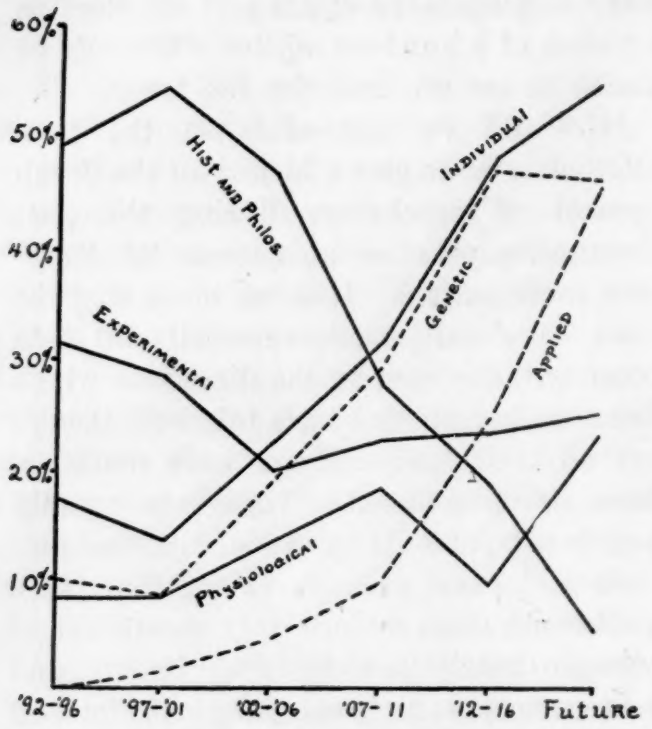

Chart showing the Distribution of Work of American Psychologists

Hall, though some of us may at times regard it as an invention of the devil. Members of the association were asked to fill in a blank stating the psychological researches in which they are engaged or plan to take up soon and the amount of time they are able to spend on research. Of the 220 who replied, 68 either reported that they are not at present doing research work in psychology or signed the blank without making a report. Of the 87 members who have not replied there are only a few who are doing work of consequence. More than 90 per cent. of those working in psychology are members of the association, and the replies consequently represent fairly well the work now in progress.

The last ordinate of the curve is for this work. When more than one research was reported the subjects were distributed fractionally so that the 152 replies give an equal number of researches and represent the work of so many individuals. The most impressive exhibition is the small amount of attention given to historical, critical, philosophical and analytical subjects, and that half of all the work is devoted to genetic and educational psychology. The suicide of philosophical papers is in part accounted for by the birth of our child—The American Philosophical Association—and does not necessarily represent a decreased interest in philosophy in America. It does, however, mean the establishment of psychology as a science completely independent of philosophy.

We are each year carrying forward more and more research work and, I trust, are continually improving its quality. We are doing a larger quantity of work than any other nation and work of equal value. But our accomplishment falls far below what it might be and should be. Psychology does not attract a sufficient number of able men and adequate opportunity is not given to them. I suppose the median salary paid psychologists who teach is less than that of employees in the railway unions, nor do we have the eight-hour day. The Ph.D. with all its outfit is a trap baited for mediocrity rather than for intelligence, and the victim gets caught at the advanced average age of 28 years. Then he must teach or starve or both. He has done research work of a kind, but whether it has been the mere routine attempt to solve a set problem or promises original performance, he is stewed in the same juice. He is not given a position unless he has done the modest amount of work required for the doctorate, but the position is usually such that further research work is prohibited. If he shows exceptional ability he may receive a minor university appointment with extension and summer courses, and if he continues to show ability he may become a dean or a president or some such thing. Scientific research and productive scholarship are regarded as desirable accomplishments, and men are sometimes called from one institution to

another because of their advertising value, or promoted in their institutions to ward off such calls; but usually the only considerable and tangible reward open to an investigator is transfer to an executive position which makes further investigation impossible.

The situation is illumined by answers to my questions. Of those who report that they are doing research work, 109 give the percentage of their working time that they are able to devote to it. Sixteen are able to give more than half their time to research, 50 from quarter to half, 43 less than quarter, 106 of our members are doing no psychological research. A man must be regarded as an amateur in work to which he does not devote more than half his time. If we add to the sixteen professionally engaged in psychological research, an equal contribution from those who did not reply to the questionnaire or to this particular question, the number would be about doubled, but they are not in fact nearly so many, and some of those who reported are doing work primarily physiological or psychiatric in nature. We have all told fewer than 25 men who are able to devote more than half their time to psychological research, men who may be regarded as professionally engaged in investigation.

It is further a misfortune or crime of the first magnitude that there is but little correlation between the performance of the men and the time they are now able to devote to research. Of the four men who state that they are able to devote all their time to such work, one is a young man temporarily out of a job, one holds a research fellowship, one a subordinate position in an industrial laboratory, one has an institutional position. If we divide the members into three classes of merit, the first 30, the second 70 and the balance of 207, in accordance with the selection by ten leading psychologists which I have previously described, and which has recently been made for the third time, we get this arrangement for those who answered the question:

Time Devoted to Research	Class I	Class II	Class III	Total
More than 50%.....	4	4	8	16
25% to 50%.....	9	15	26	50
Less than 25%.....	10	25	114	149
Total.....	23	44	148	215

The largest group, one ominously large, is not unnaturally those who do little or no research work and who are undistinguished. But apart from this group it appears that those with greater ability for research are not able to devote considerably more time to it than others.

The conditions adverse to research are not peculiar to psychology nor even to science. They hold in all cases where services are for the benefit of society as a whole rather than for individuals or groups. Men can not undertake research as a profession and be paid in accordance with the value of the work they accomplish. Aristocratic institutions have devised schemes for the reward of research, but these can not be transported overseas to a democracy. We do not want a leisure class in order to secure certain desirable by-products. A title, presentation at court, or an invitation to dine with a lord, can scarcely have an equivalent here. Membership in a national academy of sciences, a gold medal or an honorary university degree is a feeble stimulus, belonging to other days and other ways than ours. The payment of scientific men, as of soldiers, in the fiat money of honor and glory, like the inexpensive offering of happiness in heaven to compensate for meekness and misery on earth, is not a method of modern democracy.

There are four ways by which research work in psychology and other sciences can

be undertaken as a profession: (1) At our universities and colleges, in so far as these recognize that research work is part of the service for which instructors and professors are paid; (2) under the federal government, the states and the municipalities, when these regard the promotion and payment of research as a function of the state; (3) in endowed research institutions or in charitable and public institutions in which research is considered part of their objects, and (4) in cases where work can be conducted on an economic basis. For psychology we have no endowed research laboratory, the state does but little, our discoveries are not patentable and our expert knowledge is but rarely saleable. Nearly all of us are employed by universities and colleges, and we are in the main dependent on them for the opportunity to do the work that is done. Their attitude is on the whole favorable and is improving.

As secretary of a committee of the American Association for the Advancement of Science, I have addressed inquiries to all our institutions of higher education, asking the extent to which research work and productive scholarship are considered in making appointments and promotions and are regarded as part of the work for which instructors and professors are paid. Nearly all the replies emphasize the weight laid on research.

The president of Harvard University writes:

> In the making of appointments and promotions at Harvard University, greater weight, on the average, is given to scientific research and productive scholarship than to any other single consideration. Research is a part of the work expected from instructors and professors.

The president of Columbia University:

> In making recommendations for appointments and promotions in the faculties of Columbia University, the several departments concerned are expected to give predominant weight, and as matter of fact do give predominant weight, to capacity for scientific research and to evidence of productive scholarship.

The president of the University of Wisconsin:

> Scholarly work or research is a part of the work expected of instructors and professors. When presenting statements to the legislature I have estimated that upon the average from one third to one fourth of the cost should be charged to investigation.

The president of the University of Illinois:

> The work of research is fundamentally a part of the duty of the university, and this is especially true of state universities. Necessary equipment and necessary time should be allowed for every member of the staff to be actively engaged in some piece of research work all the time.

Letters such as these are full of encouragement for the future; but we must remember that it is not on university presidents and trustees but on us ourselves that the future depends.

To individual philanthropy we owe the endowment of research and of institutions expressly devoted to research. We have long had endowed astronomical observatories, and it is due to this circumstance that America has done relatively better in astronomy than in any other science. Museums, botanical gardens and similar institutions have more and more seriously added scientific investigation to their other functions. But it is only within recent years that the Carnegie Institution of Washington and the Rockefeller Institute for Medical Research have been established, and we see in them for the first time in history research in pure science conducted as a profession. There is urgent need of an adequately endowed Institute for Psychological Research; but we can scarcely expect one of our members to supply the needed ten million dollars.

Our federal government makes larger

appropriations for scientific research than any other nation, and the money has on the whole been used to advantage. The fact that the work there is mainly economic is not, in my opinion, altogether a drawback. The difficulty has been that better provision is made for routine work than for exceptional performance. The present emergency has led to further large appropriations by congress for scientific research, and we may hope that the truth expressed in the President's words "Preparation for peace is the best preparation for war" will lead to still greater efforts to promote science for the national welfare. The government has done practically nothing for psychology, and the Bureau of Education is inadequately supported. The Smith-Hughes bill, however, provides a considerable sum for educational research, a large part of which will be psychological in character. Public education is supported with increasing appreciation throughout the country and our educational systems are gradually learning the importance of psychological experts. State supported institutions for the defective and criminal classes are also beginning to make such appointments.

The patent laws were enacted before psychology had been invented; there is at present no way by which ideas can be controlled for the profit of the man who gives them to the world, even to the smallest percentage of the value of his gift. How this may be corrected may itself become an object of psychological research. If some means could be devised by which the state could pay for the services of individuals in accordance with their value to the state, the progress of science and of civilization would be greatly accelerated. In the meanwhile the psychologist may increase an inadequate salary by the writing of textbooks and by outside teaching and lecturing, but he usually does so at the sacrifice of research. There may soon be psychological experts whose advice will be paid for at the same rate as is now paid for the advice of physicians, engineers and lawyers. It is a curious circumstance that while the plan is being introduced of full-time professors of medicine with relatively adequate salaries, the professors in the graduate faculties must increasingly support their families by outside work. The cost per student or per professor of the magnificent buildings and grounds of the university where we are now meeting is perhaps four times what it once was or need now be for purposes of teaching and research, whereas the effective value of the salary of the professor at Columbia is now about one fourth what it was thirty years ago.

It is our business as individuals and especially as united in this American Psychological Association to use all possible efforts at all times, in all places and in all ways to improve the conditions under which research work is done. Science has doubled the length of human life and quadrupled the productivity of labor. A single advance in applied science, such as the Bessemer steel process or the electromagnet, discovered by Faraday in the only research laboratory then existing, may add annually some two billion dollars to the wealth of the world. The psychological and social sciences have already done their share in freeing us from superstition and unreason, in leading us to tell the truth as we see it and in some measure to see the truth as it is. They have repaid many fold their cost in economic applications. An improvement of ten per cent. in the educational work of this country saves us a hundred million dollars a year. But it is to the future that we look to obtain a control over human conduct corresponding to that of physical science over the material world, and more vital. We must eliminate the in-

calculable waste of preventable idleness, misfit employment, disease, vice, crime and war; we must divide wealth more fairly and use it more wisely, we must alter fundamentally all our institutions, the family, the church, the school, the courts, government and the rest; each must be enabled to give what he best can and to receive what he most needs. And, as I said twenty-two years ago—before that "infant industry" eugenics had begun its career—in my address as president before this association:

> We not only hold the clay in our hands to mould to honor or dishonor, but we also have the ultimate decision as to what material we shall use. The physicist can turn his pig-iron into steel, and so can we ours; but he can not alter the quantities of gold and iron in his world, whereas we can in ours. Our responsibility is, indeed, very great.

J. McKeen Cattell

AN INSTITUTE FOR THE HISTORY OF SCIENCE AND CIVILIZATION

To those interested in placing before American students advantages not only greater than are now offered in this country, but greater than those offered abroad, the following statement may suggest an opportunity.

The history of science deals with so large a part of the intellectual development of the race, that it should attract the interest of every thinking person. Such an interest is already manifest among an ever-increasing number of scientists and technicians. Furthermore, a very general interest is also becoming apparent, for example, in the history of the numerous means of locomotion from the first beasts of burden to the airplane of to-day; in the history of computation from the ingenious but rude abacus to the refined calculating machine; in the history of such methods of communication as telegraphy and telephony and in the history of medical and surgical practise.

If we consider it from a higher point of view, the importance of the history of science becomes even greater. We then realize that science is the strongest force that makes for the unity of our civilization, that it is also essentially a cumulative process, and hence that no history of civilization can be tolerably true and complete in which the development of science is not given a considerable place. Indeed, *the evolution of science must be the leading thread of all general history.*

The more scientific research becomes specialized, the more do coordinating studies of some kind become necessary to keep scientists interested in one another's work. Specialism, indispensable as it is, should not be allowed to obscure the broader vision, and there is no better way to prepare these coordinating, encyclopedic studies than to unfold as clearly as possible the evolution and interrelations of all sciences. These have not grown independently, but together, the progress of each making further progress possible for all the others. *The history of science is the essential basis of any philosophy of science, indeed of any philosophy which is not mere metaphysics or literature.*

Science is ever growing and is becoming daily a more important factor in the field of education. Science it is which makes it possible for men to tame the forces of nature to their purpose; which is the foundation of all material power; which is the backbone of our civilization. Knowledge is power, but this power may become a danger if its spirit be false and if it be bent solely upon material achievements. It is only when science is explained and tempered by history that it acquires its whole educational value, and that the main objections to scientific education cease to be valid. *The more science enters into our lives, the more it must be "humanized," and there is no better way to humanize it than to study its history.* Such studies, reconciling the purely scientific, the historic, and the philosophic points of view, would be the source of the soundest and highest idealism.

The field of the history of science as we have defined it is, of course, too broad to be adequately covered by separate departments in any of our universities. This can only be accomplished by an institution devoted strictly to this purpose and adequately equipped for

the great work that needs to be done. Such an institution should open its doors freely to the few who are sufficiently advanced to profit by its help, but it should not be hampered by any question of degrees or credits, remaining free to do for the advanced student what it feels will be of service in establishing the highest standards of research and scholarship.

An institute devoted to this work, by whatever name designated, would need to be sufficiently endowed to be independent of fees or of large financial returns from its publications. It might be established independently, with a building of its own in any city with abundant library and museum facilities, or it might be endowed to work as part of some institution already organized, such as a large university or a museum of science.

Such an institute should have among its activities the following:

1. To offer to qualified students the best equipment for work and the advice, assistance and encouragement of a small corps of experts in the history of science.

2. To afford to universities, libraries and scholars the opportunity to acquire at cost photographs of important manuscripts, documents and objects, thus making it possible to study leisurely at home many original sources that at present can only be examined abroad and at a considerable expenditure of time and money. To this end there should be secured the best available technicians, with the best types of apparatus, working both in foreign libraries and in the laboratory of the institute.

3. To offer to scientists interested in history, to historians interested in science, and to cultivated philosophers a meeting place worthy of their respect; a clearing-house where all matters of common interest to them would be centralized, examined and eventually made known to the world.

4. To begin collections of prints, instruments and all other early material bearing on the history of pure and applied science. This activity could in course of time expand into a department of enormous importance, as is clear to any one who has visited the Conservatoire des Arts et Métiers in Paris, the Science Museum in Kensington, or the Deutsches Museum in Munich, foundations with which we have nothing to compare in this country.

5. To publish two journals, one of a popular nature and the other of the highest scientific character. The former should set forth in an interesting manner the latest discoveries in the history of familiar science, appealing to the eye through the best style of illustration and to the intellect through popular but accurate and scholarly statements. It should also give much attention to the history of civilization in all its highest features, and should thus do for history, though in a more scholarly way, what has already been so successfully done for geography. The scientific journal might be a series of editions of important scientific manuscripts or a journal of the type of *Isis* which should record the world's work on the subject. In such a journal great attention should be given to bibliography, not merely external but also internal and critical. For this purpose the institute should carry on, in its own field, the coordination of the most thorough bibliographical work, mobilizing the best critical talent available.

Such an institute would not rival any department in our universities. It can and should set a higher standard of scholarship by reason of its independence, and it should be looked upon as a valuable aid by every university in this country and abroad, and as a source of supply of material which no university or library can furnish.

The institute would need to begin its work with a small staff of experts; with a small number of well-trained technicians, including photographers and process workers; with bibliographical and clerical assistants; with a well-chosen library; and with the best facilities for scientific bibliographical work. It would, of course, be necessary to do part of the work abroad, since it would be too expensive to assemble in any one place all the scholars whose cooperation would be essential to the best success. This is especially the case with respect to the Oriental civilizations, in connection with which a great amount of pioneer work remains to be done.

The international character of the institute should also be fully recognized. Although located in America, its field of influence would extend equally to all other countries and it would develop a power for internationalism the value of which could hardly be exaggerated. It is a serious misfortune that, whereas there are thousands of organizations devoted to local history, or to such auxiliary branches as heraldry, genealogy and numismatics, there is nowhere a single one that is dedicated to the historical study of that which is *the greatest common good to all mankind,* the excellent institute in Leipzig being devoted exclusively to the history of medicine. It would place the New World in another light if there could be founded here, especially at this time, an institute which might in the near future become the cradle of new intellectual movement, of a new humanism.

There is already a gratifying interest in the project. Two or three of the finest libraries on the history of science and of its special branches are likely to be given to the institute if it is founded on the lines above set forth.

The following scholars have written to express their interest and sympathy and most of them have promised some kind of collaboration:

Joseph Sweetman Ames, Wilder Dwight Bancroft, Fr. Barry, Alexander Graham Bell, George David Birkhoff, Franz Boas, Marston Taylor Bogert, James Henry Breasted, George Lincoln Burr, Florian Cajori, William Wallace Campbell, Paul Carus, William Ernest Castle, James McKeen Cattell, William Bullock Clark, Frank Wigglesworth Clarke, Thomas Chrowder Chamberlin, Russell Henry Chittenden, William Thomas Councilman, Henry Crew, Harvey Cushing, Charles Benedict Davenport, William Morris Davis, Arthur Louis Day, John Dewey, Leonard Eugene Dickson, Henry Herbert Donaldson, Jesse Walter Fewkes, Edwin Brant Frost, Fielding Hudson Garrison, George Ellery Hale, Granville Stanley Hall, Charles Homer Haskins, Lawrence T. Henderson, T. William Francis Hillebrand, William Ernest Hocking, R. F. Alfred Hoernlé, William Henry Howell, Edward Vermilye Huntington, Ellsworth Huntington, Morris Jastrow, Jr., David Starr Jordan, Louis Charles Karpinski, Arnold Carl Klebs, George Frederick Kunz, Berthold Laufer, William Libby, Frank Rattray Lillie, Ralph S. Lillie, William Albert Locy, Jacques Loeb, Graham Lusk, Percival Lowell [deceased], Franklin Paine Mall, George Herbert Mead, Samuel James Meltzer, Albert Abraham Michelson, Robert Andrews Millikan, Edward Caldwell Moore, Eliakim Hastings Moore, Ernest Carroll Moore, Arthur Amos Noyes, William Albert Noyes, William Fogg Osgood, George Howard Parker, Ralph Barton Perry, Edward Charles Pickering, Frederick Leslie Ransome, Theodore William Richards, David Riesman, James Harvey Robinson, Julius Sachs, William Thompson Sedgwick, Thomas Jefferson Jackson See, H. M. Sheffer, Paul Shorey, James Thomson Shotwell, David Eugene Smith, Edgar Fahs Smith, Edward Clark Streeter, Henry Osborn Taylor, Harry Walter Tyler, Victor Clarence Vaughan, Addison Emery Verrill, James Joseph Walsh, Arthur Gordon Webster, William Henry Welch, Edmund Beecher Wilson, James Haughton Woods.

In the matter of corespondence the undersigned will act for those interested in the movement until it is seen whether a more definite organization can be effected.

George Sarton

Harvard University,
Cambridge, Mass.

SCIENTIFIC EVENTS

TECHNICAL AND MEDICAL EDUCATION IN RUSSIA

The London *Times* states that one of the most striking features of recent educational reform in Russia has been the unusual activity of Count Ignatiev, the ex-minister of education. There has been great need of people of higher education in Russia in two departments especially, the technical and the medical. In November last Count Ignatiev brought before the Duma a scheme for a new university statute introducing far-reaching reforms. Meantime many new technical and medical schools are already being provided for. Ten new technical institutes of various types are in process of organization, and in this connection Count Ignatiev approached the municipalities and Zemstva concerned, with a view to sharing the expense. These technical institutes are to be opened especially in the eastern part of the empire, in Saratov, Vyatka,

Turkestan and Blagoveshchensk. Of the several new universities which are under consideration, the first to be opened will be those of Perm and Rostov-on-the-Don. The scheme for the University of Irkutsk is to be brought before the Duma in the autumn of 1917, and another university in the Far East is planned for either Vladivostok or Habarovsk. All the towns which have been chosen as new centers of education have already voted sums of money, larger or smaller, according to their wealth. Some of the old universities—viz., those of Odessa and Tomsk, have been allowed to increase the number of their students. Perhaps the most marked reforms are in medical education, since Russia is faced with a greater need for medical staff than any other country. A new degree of candidate of medical science has been founded which, together with eight months' hospital training, entitles the holder to practise. The holder of this degree occupies an intermediate place between the fully qualified doctor and the so-called *feldscher* or nurse (male or female), who is allowed to practise in the absence of a doctor. There are also schools for four more classes of medical staff—disinfectors, maternity nurses, nurses for nervous cases and masseurs. These reforms are already being set in motion, and are to be carried out in the course of the next three years.

DINNER IN MANILA TO VISITING SCIENTIFIC MEN

A CORRESPONDENT writes from Manila:

On February 5, 1917, Dr. John A. Brashear, the noted American maker of photographic lenses and silver-on-mirrors, Dr. A. Swasey, president of the firm that made the mounting of the big Cordoba, Lick, Yerkes, Victoria telescopes, and Dr. John R. Freeman, the American hydraulic engineer, were entertained at a lunch given in their honor at the Manila Hotel by prominent scientists and engineers of Manila. To meet in the far-off Philippine Islands so many friends, enthusiastic for astronomy and for the application of modern machinery and methods to engineering problems was a delightful surprise to the distinguished visitors. José Algué, director of the Weather Bureau, welcomed the guests and acted as toastmaster. The speaker of the occasion was a personal friend of Dr. J. A. Brashear. Speaking of optical instruments made by Brashear, Rev. M. Selga, well known in America for his connection with the leading American observatories, made the following remark: "There is hardly any remarkable astronomical observatory in America that is not equipped either with a silver-on-mirror, or a lens, or a comet-seeker, or an alt-azimuth or a spectrograph constructed by Brashear. The 8″ doublet of Swarthmore College Observatory, the 15″ of the Dominion Observatory, Ottawa, Canada, the 18″ of the Flower Observatory, Philadelphia, Pa., the 20″ of Chabot Observatory, Oakland, California, the focus of the astronomical admiration of the visitors at the Panama-Pacific Exhibition, the unique 30″ photographic refractor of the Allegheny Observatory are but few among the many high-grade refractors turned out by Brashear. You are all acquainted with the spectrographic investigations of the late Dr. Young, at Princeton, of Dr. G. H. Hale at Kenwood, paving the way for the advance of solar physics and the establishment of the Mt. Wilson Solar Observatory, of Dr. F. Schlesinger at the Allegheny Observatory with the Mellon and Porter spectrograph, of Dr. Frost with the Bruce, of Plaskett at Ottawa, of Dr. Slipher at Flagstaff, and specially of Dr. W. W. Campbell who with the Mills spectrograph has surveyed the northern and southern skies for the spectral characteristics of the stars. Now, one of the vital parts, either the prisms or the lenses, of these unparalleled spectrographs are from Brashear." The guests gathered around the table at 12 o'clock and the steamer was to take the scientific party from Manila to Hongkong at 3 P.M. Few minutes were left to Dr. Brashear to talk on the stars, to Dr. Swasey to give his views about the Far East and to Dr. Freeman to report on the past, present and future condition of the Panama landslides. The speeches were short, but they were a source of pleasure and delight to more than a hundred guests and will be long remembered.

THE KANSAS CITY MEETING OF THE AMERICAN CHEMICAL SOCIETY

As has been already noted in SCIENCE the American Chemical Society will meet at Kansas City from April 10 to 14. The society and hotel headquarters will be at the Hotel Muehlebach. The final and complete program will be sent on or about April 3 to members requesting it. The program of general arrangements is as follows:

Tuesday, April 10

6.30 P.M. Dinner to the council at the University Club (tendered by the Kansas City Section).

8.15 P.M. Council meeting. Assembly room, Hotel Muehlebach.

Wednesday, April 11

10 A.M. General meeting of the society in the Hotel Muehlebach.

Addresses of Welcome.

Hon. George H. Edwards, mayor of Kansas City;

Dr. Frank Strong, chancellor of the University of Kansas.

Response:

Julius Stieglitz, president American Chemical Society.

General Papers:

"The Economic Resources of the Kansas City Zone." Arthur J. Boynton.

2 P.M. Public Session. Hotel Muehlebach.

"Petroleum and Natural Gas." Dr. H. P. Cady, chairman.

8 P.M. Smoker. Hotel Muehlebach.

All sessions and division meetings of the society will be held, as far as possible, in the Hotel Muehlebach, on the mezzanine floor.

Tuesday night, April 10. Council dinner and meeting.

Wednesday morning, April 11. Opening session.

Wednesday afternoon, April 11. Public session. "Petroleum and Natural Gas."

Wednesday night, April 11. Smoker.

Thursday morning, April 12. Division meetings.

Thursday afternoon, April 12. Division meetings.

Thursday night, April 12. Banquet.

Friday morning, April 13. Division meetings.

Friday afternoon, April 13. Excursions.

Friday night, April 13. Open.

Saturday morning, April 14. Excursions.

The following are the addresses of the divisional secretaries:

Agricultural and Food Chemistry: Glen F. Mason, H. J. Heinz Co., Pittsburgh, Pa.

Biological Chemistry: I. K. Phelps, Bureau of Chemistry, Washington, D. C.

Fertilizer Chemistry: F. B. Carpenter, Virginia-Carolina Chemical Co., Richmond, Va.

Industrial Chemists and Chemical Engineers: S. H. Salisbury, Jr., Northampton, Pa.

Organic Chemistry: H. L. Fisher, Columbia University, New York City.

Pharmaceutical Chemistry: George D. Beal, Chemistry Building, University of Illinois, Urbana, Ill.

Physical and Inorganic Chemistry: Earl V. Millard, Institute of Technology, Boston, Mass.

Water, Sewage and Sanitation: H. P. Corson, U. S. Public Health Service, Grove City, Pa.

SCIENTIFIC NOTES AND NEWS

The following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society: Dr. J. H. Ashworth, Mr. L. Bairstow, Professor G. A. J. Cole, Mr. C. F. Cross, Dr. H. D. Dakin, Professor A. S. Eve, Professor H. Jackson, Professor J. S. Macdonald, Professor J. W. Nicholson, Dr. R. H. Pickard, Mr. C. T. Regan, Dr. R. Robertson, Dr. E. J. Russell, Mr. S. G. Shattock and Professor F. E. Weiss.

The membership of the Botanical Committee of the National Research Council has just been completed, as follows: From the National Academy, J. M. Coulter (chairman), D. H. Campbell, R. A. Harper; from the American Association for the Advancement of Science (Committee of One Hundred), George T. Moore, B. E. Livingston, L. R. Jones; from the Botanical Society of America, Erwin F. Smith, Edward M. East and H. H. Bartlett.

At the request of the National Research Council there has been appointed at the College of the City of New York a research committee, consisting of Professor Charles Baskerville, chairman; Professors T. A. Storey, F. G. Reynolds, Geo. G. Scott, J. G. Coffin, F. E. Breithut and A. N. Goldsmith.

The Adams prize at Cambridge has been awarded to Mr. J. H. Jeans, M.A., sometime fellow of Trinity, for an essay on "Some Problems of Cosmogony and Stellar Dynamics." No election has been made to the Isaac Newton Studentship.

Mr. John W. Titcomb, fish and game commissioner of Vermont, has been appointed by the conservation commission fish culturist for the state of New York, to fill the vacancy caused by the death of Dr. Tarleton H. Bean.

Professor A. A. Benedict has been appointed associate professor in physics in the University of South Carolina, filling the va-

cancy caused by the resignation of Dr. Lucian, who will take up research work for the Green and Bauer Company, of Hartford, Conn.

PROFESSOR J. C. MERRIAM, of the University of California, will give a paper on "A Plan for Cooperation in Research among the Scientific Societies of the Pacific Coast" in the symposium, under the direction of Dr. D. T. MacDougal, before the Stanford meeting of the Pacific Division of the American Association for the Advancement of Science.

GENERAL GEORGE W. GOETHALS gave an illustrated lecture on the Panama Canal at Cornell University on March 5.

DR. W. D. BANCROFT, professor of physical chemistry at Cornell University, addressed the Indiana branch of the American Chemical Society, at Indianapolis, on March 9, on "Contact Catalysis"; and on March 10, Professor Bancroft spoke before the Society of Sigma Xi of Indiana University on "Colloid Chemistry."

DR. WILLIAM S. THAYER, of the Johns Hopkins University, delivered an address before the New York Academy of Medicine, on March 15, on "The Significance of Some Common Deviations from the Ordinary in Cardiac Function."

MR. N. H. DARTON, of the U. S. Geological Survey, recently lectured to Lehigh University on "The Grand Canyon of Arizona, a Great Object Lesson in Geology and Geography." A large number of new views and other illustrations were shown.

PROFESSOR C. M. CHILD, of the department of zoology of the University of Chicago, will give the principal address before the Science Section of the Colorado Educational Association at the spring meeting to be held at Teachers College in Greeley on March 30 and 31.

DR. WILLIAM R. BROOKS, director of Smith Observatory, and professor of astronomy at Hobart College, recently delivered his illustrated lecture on "The Wonders of the Heavens," at the Rhode Island State College at Kingston.

THE magnetic-survey vessel, the *Carnegie*, under the command of J. P. Ault, arrived at Buenos Aires, with all well on board, on March 2. Leaving San Francisco on November 1, 1916, he proceeded to Easter Island, thence around the Horn to Buenos Aires. The scientific work was successfully accomplished on the entire trip.

THE daily papers report that Vilhjalmur Stefansson, the Arctic explorer, is wintering with the gasolene schooner *Polar Bear* at Prince of Wales Strait, according to news brought by a Northwest police expedition from Fort McPherson. Stefansson, who passed last summer exploring the new land discovered north of Prince Patrick Island, is hopeful that the ice will break up early this spring and permit him to make the northeast passage and to sail up the St. Lawrence River to Montreal.

PROFESSOR WILLIAM BEEBE, of the faculty of mathematics of Yale University, died on March 11, in New Haven, in the sixty-sixth year of his age. He was graduated from Yale in 1873, and had been teaching there since 1876.

DR. JOHN S. MCKAY, head of the department of physics and mathematics of the Packer Collegiate Institute, Brooklyn, from 1890 to his retirement last summer, has died at the age of sixty-seven years.

THE library of the American Institute of Mining Engineers has received a gift of $100,000 from Mr. James Douglas, of Arizona.

A CHAPTER of Sigma Gamma Epsilon, the national collegiate fraternity devoted to geology, mining and metallurgy, was installed in the University of Nebraska on the evening of March 3. Communications intended for the national officers should be addressed to Mr. Harry E. Crum, Lawrence, Kansas.

A CIRCULAR letter giving 39 generic names in Protozoa, Cœlenterata, Trematoda, Cestoda, Cirripedia, Tunicata and Pisces, chiefly Linnæan, which have been proposed for inclusion in the Official List of Zoological Names, has been mailed to the leading scientific institutions, colleges, laboratories, etc., in various countries; in addition 20 copies have been sent

to each commissioner for distribution in his own country. A copy will be sent to any person sufficiently interested, who will apply to Dr. C. W. Stiles, secretary to International Commission on Zoological Nomenclature, U. S. National Museum, Washington, D. C.

Sir Alfred Keogh, director-general of the British army medical service, presiding at a lecture at the Royal Institute of Public Health on February 14, is reported in *Nature* to have stated that in France at that moment there were only five cases of enteric fever and eighteen cases of paratyphoid fever, with seventy or eighty doubtful cases. He attributed this result to inoculation, and the general good health of the army to good food, in addition to careful sanitation. The health of the army at all the fronts was said to be better than the ordinary health of the army in peace-time.

Dr. Leo J. Frachtenberg, of the Bureau of American Ethnology, returned to Washington, D. C., on February 4, after a stay of almost two and a half years in Oregon and Washington, where he investigated the ethnology, mythology and languages of the various Indian tribes scattered throughout these states. Dr. Frachtenberg's researches in this area have resulted in evidence that three of the most important linguistic stocks of the northwest, namely, the Salish, Wakashan and Chimakuan, have ultimately been derived from one common stock, which he proposes to call the Mosan group. This name has been suggested by the fact that the numeral 4 (*mós* or *bós*) occurs in each of these stocks in one form or another. While working on the social organization of the Chimakuan tribes Dr. Frachtenberg observed an entirely new feature in the social life of the American Indians. This feature consists of the existence of professional orders, whose members do and must follow one and the same profession. Thus there are special orders for fishermen, hunters, sealers, whalers, shamans, rainmakers, etc. During the last two weeks of his stay in the west Dr. Frachtenberg succeeded in raising a fund of $25,000 as a nucleus for the purposes of organizing a Museum of Natural History in the city of Portland, Oregon. On January 29 he succeeded in starting a similar movement in Spokane, Washington, and it is hoped that the city of Spokane will in the near future have a museum specially devoted to the American Indians of that region.

Preliminary estimates by John D. Northrop, of the United States Geological Survey, Department of the Interior, indicate that the quantity of crude petroleum produced and marketed in the old fields of the United States in 1916 was 292,300,000 barrels. This quantity is greater by 4 per cent. than the corresponding output in 1915, which reached the record-breaking total of 281,104,104 barrels. Mr. Northrop estimates that 38 per cent. of the 1916 total came from the Oklahoma-Kansas field, 30 per cent. from California, and the remaining 32 per cent. from the Appalachian, Lima-Indiana, Illinois, north Texas, north Louisiana, Gulf coast, and Rocky Mountain fields.

In 1916 Alaska mines made a mineral production valued at $50,900,000. These are the advance figures issued by the United States Geological Survey, Department of the Interior, and are based on estimates made by Alfred H. Brooks. The output of Alaska mines in 1915, which was greater than that of any previous year, had a value of $32,850,000, and the increase in 1916 was therefore over 54 per cent. It was the product of the copper mines that so greatly swelled the mineral production of the year. This amounted to 120,850,000 pounds, valued at $32,400,000. There was also, however, an increase in gold output, which in 1916 was $17,050,000 and in 1915 was $16,700,000. Of the gold produced in 1916, $10,640,000 is to be credited to the placer mines. Alaska also produced in 1916 silver, lead, tin, antimony, tungsten, petroleum, marble, gypsum and coal to the value of $1,300,000. During 32 years of mining Alaska has produced $351,000,000 in gold, silver, copper and other minerals. Of this amount $278,000,000 represents the value of the gold, and $68,000,000 that of the copper.

UNIVERSITY AND EDUCATIONAL NEWS

The legislature of Kansas appropriated $1,524,000 for the University of Kansas for the

next biennium, and $1,250,000 for the Kansas State Agricultural College. The three normal schools were given approximately $970,000, and the various other schools and sub-experiment stations $242,000. The total appropriation for all designated educational institutions was a little less than four million dollars for the two years beginning July 1, 1917.

THE will of the late William W. Lawrence, president of the National Lead Company, provides that on the death of Mrs. Lawrence a sum of over $200,000 will go to Princeton University.

A BILL has been enacted in New Jersey designating the scientific departments of Rutgers College as the State University of New Jersey.

ARRANGEMENTS have been completed between Northwestern University Medical School and the Chicago Fresh Air Hospital for a course of instruction in tuberculosis for the members of the senior class in the medical school. The class is divided into sections, each receiving clinical instruction for a period of four weeks.

To meet the increased cost of supplies and to permit an enlargement of educational facilities, tuition in the medical school of George Washington University has been increased from $150 to $175 a year, and in the dental school from $125 to $150, to take effect next fall.

DR. SCOTT NEARING has presented his resignation at Toledo University owing to criticisms made by citizens of the city of his anti-militaristic activities. It will be considered by a committee of the trustees.

IN accordance with the reorganization plan at the Creighton University College of Medicine, the bio-chemical and physiological laboratories have been merged into a single department under the direction of Professor S. Morgulis. Dr. William A. Perlzweig, of the Rockefeller Institute, has been appointed assistant professor of bio-chemistry in the department.

DR. ETHAN A. GRAY, medical superintendent of the Chicago Fresh Air Hospital, has been appointed assistant professor of medicine in Northwestern University.

DISCUSSION AND CORRESPONDENCE

A RELIEF MAP OF THE UNITED STATES

TO THE EDITOR OF SCIENCE: Mr. Kinkaid's proposition (SCIENCE, March 9), to construct a relief map of the United States "300 feet square or 600 feet square" would be, judging from my own experience, a pretty costly one. A relief map of the state of New York 35 feet long, east and west, and 26 feet broad, north and south, now in our museum, cost $17,000 to make. Estimating broadly the dimensions, area and cost of a map of the entire United States on the same scale, the map would be 237.5 feet long, and at the same proportion of cost the expense of making it would be $1,045,500. This is on the scale of one mile to the inch. If the scale were one half mile to the inch, the cost would be, in the same proportion, $4,182,000.

And where in Washington or elsewhere would Mr. Kinkaid put such a map of the United States, 600, or even 300 feet long? There is no building large enough to hold it. Buildings 600 feet long and 300 feet wide are not bagatelles. Perhaps one might be built for a million dollars, but it is doubtful.

Surely for this proposition, as Mr. Kinkaid suggests, "the main problem is to find the philanthropist." But before going out to hunt him, let us remember that only 40.2 per cent. of the United States has been covered by topographic surveys in such detail as to give an adequate basis for such a relief map as he has dreamed of.

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AN ANCIENT REFERENCE TO THE EMERALD

OUR college librarian, Professor Chipman, while arranging a course on "Books and Libraries" happened to call my attention to a translation of the oldest known manuscript which could justly be called a book, an Egyptian parchment entitled "The Instruction of Ptah-hotep."[1] In glancing it through I came across this interesting sentence:

[1] Translated by B. G. Gunn. E. P. Dutton, 1910.

Fair speech is more rare than the emerald that is found by slave-maidens on the pebbles.

Since the actual parchment is said to date from 2500 B.C., and since Ptah-hotep lived about 3500 B.C., this gives us a written mention of the emerald and its occurrence as a placer mineral on a document 4,500 years old, and shows that it was prized as a gem about 5,500 years ago, perhaps 2,500 years before the "Iliad" and "Odyssey" had come into existence, and over 2,300 years before the traditional date of the siege of Troy.

Whether the word here translated emerald is strictly the emerald as we define it I do not know. At any rate such a translation harmonizes with the usual implication that Egypt is the place of earliest recognition of the stone. The Encyclopedia Britannica, for instance, says:

Ancients appear to have obtained the emerald from upper Egypt, where it is said to have been worked as early as 1650 B.C.

The document under discussion shows that it was searched for and prized almost 2,000 years before this.

The same publication that contains the "Instruction of Ptah-hotep" contains a short "Instruction of Amenemhê'et" who ruled in Egypt about 2778–2748 B.C. He remarks:

I have made me an house adorned with gold, its ceilings with lapis lazuli. . . .

This document in the part quoted is said not to be so reliable as the preceding one.

Since a geologist would only by accident have this book called to his attention, it seems worth while to quote such ancient—so far as I know the most ancient—references to these minerals.

Homer P. Little
Colby College,
Waterville, Maine

METHYL AND ETHYL ALCOHOL

To the Editor of Science: When the Mapp prohibition law, which went into effect in Virginia last November, was before the state legislature we communicated with our representative, asking that the interests of the colleges be safeguarded in respect to the use of alcohol for scientific purposes, but the law as enacted ignores biological laboratories entirely. We are therefore compelled to seek a substitute for ethyl alcohol, at least until the law can be amended. Hence the following queries:

1. Can methyl alcohol be substituted generally in processes of dehydration without modifying the methods otherwise or without prejudice to the staining or keeping qualities of the preparations?

2. Can methyl alcohol be generally substituted in the formulas for stains, etc.?

3. Are there any special cases in which this substitution may not be made?

4. What kind of methyl alcohol should be used?

The manuals on histological technique give little information on this question, but it may be that someone in "bone dry" territory has found a substitute for ethyl alcohol. If so, there are a number of readers of Science who would be grateful to hear of it.

J. I. Hamaker
Randolph-Macon Womans' College,
Lynchburg, Va.

SCIENTIFIC BOOKS

Institut de France. Académie des Sciences, Annuaire pour 1917, Paris, Gauthier-Villars et Cie. sm. 8vo (17 × 11 × 1.3 centimeters). 315 pp.

The Yearbook of the Académie des Sciences bears but slight trace of the terrible experience through which France is now passing, an experience all well-wishers of our traditional friend trust will have a speedy ending. It is thus a grateful sign that science may pursue her way unperturbed by the conflicts of the hour, and may have nothing to unlearn or to forget when the period of destruction and suffering brought about by an outbreak of man's basest passions shall have at last been brought to a close.

The most attractive part of the *Annual* for one interested in the history of science is the complete biographical index of all the members and correspondants from 1795 to 1917 (pp. 111–288). In this register of 1,188 names appear all the leaders in French science for the

period mentioned, and a large number of those in foreign lands. The name of one of the greatest men in the world's political history is also to be found here, that of Napoleon Bonaparte, who was elected resident member of the section of mechanical arts in the First Class of the reorganized Institut National, on December 25, 1797 (5th Nivôse An VI.); two years later he became president of this class. It should be borne in mind that this was at the very outset of his career, in the year of the first Italian campaign. In our own day another soldier of France, General Gallieni (died May 27, 1916), who aided greatly in the defense of Paris during the critical first weeks of September, 1914, was a correspondent of the section of geography and navigation.

One of the most interesting figures among the academicians of the past century was the centenarian chemist, Michel Eugène Chevreul, born September 1, 1786, elected member of the section of chemistry, August 7, 1826, president of the Académie in 1839 and 1867 and who died in Paris April 9, 1889, aged one hundred and two years, seven months and eight days, his lifetime extending from the reign of Louis XVI. down to the centenary of the French Republic.

The oldest member living at the time the *Annuaire* went to press was the rural economist Jean Jacques Schlœsing, born in Marseilles, July 9, 1824, and therefore now in his ninety-third year. The Académie counts two other nonogenarians, the rural economist Auguste Chauveau, born November 21, 1827, and the mathematician Charles Wolf, born November 27, 1827; there are a half-dozen octogenarians.

Of the correspondents chosen from 1795 to 1917, eighteen were born in the United States; three of them, the astronomers Edward Charles Pickering and George Ellery Hale, and William Morris Davis, correspondent of the section of Geography and Navigation, are still living.

The organization of the Académie at the present time permits the election of 66 full members (Membres Titulaires), six for each of the eleven sections. There are besides two perpetual secretaries, one for the division of mathematical sciences, the other for that of physical sciences, ten Académiciens Libres, six Membres Non Résident, and twelve Associés Étrangers; to these may be added 116 correspondents. The full complement in the different classes, and the number actually registered at present, are given as follows:

	Allowed by Statutes	Registered in Yearbook
Membres Titulaires	66	57
Secrétaires Perpétuels	2	2
Académiciens Libres	10	9
Membres Non Résidents	6	4
Associés Étrangers	12	6

The members of the Académie are distributed in eleven sections, the division *sciences mathématiques* comprising five sections, geometry, mechanics, astronomy, geography and navigation and general physics, the *sciences physiques* embracing the following six sections: chemistry, mineralogy, botany, rural economy, anatomy and zoology, and medicine and surgery. Each of these eleven sections is restricted to a membership of six, so that a scientific specialist, however great his renown, must await not merely a vacancy in the Académie, but one in the particular section to which he belongs. By this means an equal balance is always maintained and there can be no undue preponderance of any single scientific branch, or of any group of such branches.

G. F. K.

THE PINK BOLL WORM

THE newspapers of the country in the last few months have called attention to the fact that a most serious pest of the cotton plant known as the pink boll worm (*Gelechia gossypiella* Saund.) has been established in northern Mexico through the shipment of several tons of Egyptian cotton seed to that country in 1910. The insect is one which is especially likely to be transported over long distances. It can live for more than a year in stored cotton seed, thus furnishing an opportunity for shipment to the remotest parts of the globe. As a matter of fact it was carried from

India, which was probably its original home, to Egypt about a dozen years ago in cotton seed.

The Department of Agriculture has undertaken strenuous measures to prevent the introduction of the pink boll worm from Mexico. The introduction of cotton seed and of baled cotton which often carries scattered seeds has been prohibited, and Congress has made a special appropriation under which very thorough work in enforcing quarantine measures can be done on the Texas border.

It is interesting to note the recent experience of Brazil with the pink boll worm. In 1913 the Brazilian government paid considerable attention to the encouragement of the culture of Egyptian cotton in that country. An agent was sent to Egypt and large quantities of seed were shipped to Brazil. This seed was distributed throughout the republic by a branch of the Ministry of Agriculture. This branch has inspectors in every state capital. Each one of these received quantities of the seed and distributed it free to all applicants. A more thorough method of dissemination of an insect in a new country could hardly be devised. Early in 1914 a careful survey of the cotton belt of Brazil was made by an American who was engaged in the encouragement of cotton culture in the republic. He found no indications of the cotton boll weevil for which he was looking especially or of any other insect pest attacking the seed or bolls. Late in 1916 he made another trip over the same territory and found that the pink boll worm was generally and thoroughly established. In fact the pest was so numerous that the yields of certain fields were reduced by half. Naturally the situation attracted great attention and many suggestions were made about relief measures. Some of the legislators suggested the passage of a law compelling the burning of all cotton fields in Brazil. Of course it is too late to stamp out the insect by any such means, but the whole episode emphasizes enormously the importance of quarantine measures to prevent the introduction of pests which in all probability can never be exterminated when they have once become established.

W. D. Hunter
Bureau of Entomology

SPECIAL ARTICLES

THE EFFECT OF RETARDATION OF GROWTH UPON THE BREEDING PERIOD AND DURATION OF LIFE OF RATS[1]

During the course of our experiments on nutrition we have had a number of rats which were stunted for various periods of time. With respect to these animals the question has frequently been raised as to whether this retardation of growth tended to prolong their life beyond the average span; that is, whether physiological age is a function of time alone or also of growth. The inquiry then becomes pertinent as to what may be considered the average length of life of a rat.

Donaldson[2] states that "a rat three years old may be regarded as corresponding to a man ninety years old." Slonaker[3] has reported that one of his rats reached an age of 45 months; and recently one of our rats, although fed on a uniform experimental diet since it was 6 weeks old, reached the age of 40 months —the longest life yet recorded for our colony. In an attempt to find out how long our rats might be expected to live, we have at various times set aside a number of stock rats to be kept under our ordinary laboratory conditions during their entire lifetime. Out of 91 such animals, 17 (19 per cent.) died under one year of age; 48 (53 per cent.) died between one and two years of age; and 26 (29 per cent.) lived more than two years, the oldest one reaching an age of nearly 34 months. From these figures it is evident that less than a third of the rats in our colony may be expected to live to be more than two years old.

Considering the wide variations in the ages of these rats it was thought that possibly a more definite, although an indirect answer to the question of the effect of stunting upon the length of life might be obtained by determining the age to which stunted females remain

[1] The expenses of this investigation were shared by the Connecticut Agricultural Experiment Station and the Carnegie Institution of Washington, D. C.

[2] Donaldson, H. H., "The Rat," Memoirs of the Wistar Institute, No. 6, Philadelphia, 1915.

[3] Slonaker, J. R., *J. Animal Behavior*, 1912, II., 20.

Rat	Stunting Period Began at		Growth Resumed at		Brood I			Brood II			Brood III			Brood IV			Brood V			Brood VI			Death	
	Age	Weight, Gm.	Age	Weight, Gm.	Age	No. in Litter: Born	No. in Litter: Survived	Age	No. in Litter: Born	No. in Litter: Survived	Age	No. in Litter: Born	No. in Litter: Survived	Age	No. in Litter: Born	No. in Litter: Survived	Age	No. in Litter: Born	No. in Litter: Survived	Age	No. in Litter: Born	No. in Litter: Survived	Age	Cause
2031 ♀	1 mo. 13 da.	48	17 mo. 21 da.	108	23 mo. 19 da.	4	4	25 mo. 21 da.	5	5	28 mo. 5 da.	3	2	28 mo. 9 da.	8	8							32 mo. 18 da.	Lung disease
2339 ♀	1 mo. 8 da.	48	13 mo. 0 da.	104	17 mo. 17 da.	8	6	19 mo. 23 da.	9	9	22 mo. 11 da.	8	8	25 mo. 9 da.	12	12	29 mo. 20 da.	6	6	31 mo. 25 da.	2	0	32 mo. 15 da.	Lung disease
2369 ♀	1 mo. 15 da.	79	12 mo. 15 da.	103	16 mo. 23 da.	12	12	19 mo. 2 da.	7	6	21 mo. 7 da.	12	12	25 mo. 9 da.	2	2							27 mo. 17 da.	Lung disease
2446 ♀	1 mo. 13 da.	90	6 mo. 4 da.	90	16 mo. 0 da.	7	7	18 mo. 0 da.	3	1	20 mo. 19 da.	10	9	25 mo. 9 da.	5	0							26 mo. 10 da.	Lung disease

fertile. According to Donaldson[2] the menopause normally occurs at the age of 15 to 18 months, although he reports one female which, mated at the age of 22 months, produced a litter of one. The young was not reared, however.

Four of our stunted females were mated at various times. The results are summarized in tabular form. Data regarding their early stunting and subsequent resumption of growth have been published elsewhere.[4] In every case the female was not remated until some time after the birth of a litter, as the maximum number of broods which she could bear was of much less interest than the final age at which she was capable of producing young. Although none of these rats began breeding until they had reached an age when normal rats are commonly believed to be approaching the menopause, they produced from three to six litters of young and successfully reared all but a few of them. Their young were apparently as vigorous as those born of younger mothers. Hence the menopause has been postponed long beyond the age at which it usually appears. In view of this, and the added fact that less than one third of our stock rats have reached an age of more than two years, whereas all of these stunted females lived longer, it appears as if the preliminary stunting period lengthened the total span of their life.

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THE MATHEMATICAL ASSOCIATION OF AMERICA

THE second annual meeting of the Mathematical Association of America was held at Columbia University, New York City, on Thursday, Friday and Saturday, December 28–30, 1916, in affiliation with the American Association for the Advancement of Science. There were 184 persons present at the various meetings, including 141 members of the association. The first meeting was a joint session

[4] Osborne, T. B., and Mendel, L. B., *J. Biol. Chem.*, 1915, XXIII., 439; *Am. J. Physiol.*, 1916, XL., 16.

with the American Mathematical Society, Section A of the American Association, and the American Astronomical Society. At this session Professor Ernest W. Brown, the retiring president of the society, gave his retiring address on "The Relations of Mathematics to the Natural Sciences." This was followed by the retiring address of Professor A. O. Leuschner, vice-president of Section A of the American Association, on "Derivation of Orbits—Theory and Practise." A joint dinner of these four organizations was held Thursday evening, following which speeches were made by Professor Florian Cajori, President R. J. Aley, Mr. William Bowie, Professor J. A. Miller, Mr. G. A. Plimpton, and Professor Dunham Jackson.

The meeting on Friday morning was first addressed by Professor Florian Cajori, of Colorado College, who read a paper on "Discussions of Fluxions from Berkeley to Woodhouse." Professor M. W. Haskell, of the University of California, gave a paper entitled "University Courses in Mathematics Intended for Teachers of Secondary Mathematics." This was followed by a discussion led by Professor J. W. Young, of Dartmouth College, and Professor Edward Kasner, of Columbia University. During the time between the morning and afternoon sessions, opportunity was afforded by Professor David Eugene Smith for the inspection of his admirable collection of portraits and medals of mathematicians. On Friday afternoon was held the meeting of institutional delegates. This department of the association was organized for the consideration of those phases of collegiate mathematics which are of an institutional character rather than of merely individual interest; such questions as entrance requirements, requirements for degrees, maintenance of libraries, etc., will properly come under this department. The program was devoted to the subject of mathematical libraries, and consisted of a paper on "A Nucleus for a Mathematical Library," by Dr. T. H. Gronwall, of New York City, and of the reading of a report from the recently appointed library committee by the chairman, Professor W. B. Ford, of the University of Michigan, with an accompanying discussion. The program closed on Saturday morning with an address on "The Mathematics of Aërodynamics" by Professor E. B. Wilson, of the Massachusetts Institute of Technology, with a discussion led by Professor A. G. Webster, of Clark University.

The annual election is conducted both by mail and in person at the meeting; in this way a total of 405 ballots was received. The list of officers elected for the year 1917 is given herewith:

President, Florian Cajori.

Vice-presidents, Oswald Veblen, D. N. Lehmer.

Secretary-Treasurer, W. D. Cairns.

Members of the executive council to serve until January 1920, E. R. Hedrick, Helen A. Merrill, R. E. Moritz, D. E. Smith.

E. V. Huntington was chosen by the council to fill the vacancy caused in the council by the promotion of Professor Cajori to the presidency.

Fifteen persons and sixteen institutions were elected to membership; thus 1,064 individuals (deducting the number of those who have died during 1916) and 76 colleges and universities of the United States and Canada now hold membership in the association. Applications from thirteen individuals and one institution have been received since the New York meeting.

The association has a system of sections organized by the members of the various groups, mostly those within state lines. Such sections now exist in Kansas, Ohio, Missouri, Iowa, Indiana, Kentucky and Minnesota, with a section covering Maryland, the District of Columbia, and Virginia.

The report of the treasurer showed that a fund of $958.72 had been transferred to the association from the former management of the *American Mathematical Monthly,* and that the business for the year 1916 closed with a balance of approximately two hundred dollars.

An important arrangement has been entered into by the association with the *Annals of Mathematics,* which bids fair to exert an important influence upon the development of collegiate mathematics, in that it will foster the production and publication of articles of an expository and historical nature. In consideration of a subvention from the association, the board of editors of the *Annals* will increase the size of the magazine from 200 pages (its present size) to 300 pages annually, beginning with the number for June, 1917. The subscription price for individual members of the association will be one half of the ordinary price, which latter will be three dollars instead of the present price, two dollars.

The summer meeting of the association will be held by invitation of Case School of Applied Science and Western Reserve University at Cleveland, Ohio, on September 6 and 7, in conjunction with the meeting of the American Mathematical Society, with which the association has rightly so much in common. The next annual meeting will be held by invitation at the University of Chicago next December, in connection with the meeting of the Chicago Section of the society.

W. D. Cairns,
Secretary-Treasurer